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FIELD EVALUATION OF CHEMICAL COMPOUNDS FOR CONTROL OF CABBAGE CATERPILLARS

By C. S. Creighton and W. J. Reid, Jr.[1]
Entomology Research Division[2]

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Prochaska et al. (1964)[3] reported results of field tests conducted in 1961 and 1962 in which certain compounds were evaluated for their effectiveness against the cabbage looper [*Trichoplusia ni* (Hübner)], the imported cabbageworm [*Pieris rapae* (L.)], and the fall armyworm [*Spodoptera frugiperda* (J. E. Smith)]. This paper reports results obtained with additional chemical compounds that were evaluated in field tests conducted on spring and fall cabbage crops in 1963, 1964, and 1965, and is not a recommendation of any of the chemicals mentioned.

Most of the new compounds tested had shown promise previously against the cabbage looper in laboratory-screening studies at Charleston, S.C.

METHODS

The tests were conducted on the Clemson University Truck Experiment Station grounds. Each of the experimental treatments was replicated six times on single 3- by 50-ft. rows of cabbage plants in randomized blocks. Unless otherwise indicated, the compounds were formulated as emulsifiable concentrates and were applied as sprays with a hand-operated knapsack sprayer at approximately 50 gallons per acre. Five applications were made at 7-day intervals each spring beginning early in May and extending to early in June. With the exception of 1964, five applications were also made at 7-day intervals in the fall, beginning in mid-September and extending to mid-October. In 1964, seven applications were made at 7-day intervals between mid-September and mid-November.

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[2] In cooperation with the South Carolina Agricultural Experiment Station.

[3] Prochaska, R. G., Cuthbert, F. P., Jr., and Reid, W. J., Jr. Zectran and Bayer 44646 Show Most Promise in Control of Cabbage Caterpillars. Jour. Econ. Ent. 57: 490-492. 1964.

Evaluation of the compounds was based on the number of surviving caterpillars, by species, on 10 plants per plot on the second day after each spray application; also, on the degree of caterpillar injury to the plants at harvest. Plant damage was estimated according to a system of classification reported by Reid (1940).[4] Plants whose firm head and four wrapper leaves were free of visible caterpillar feeding were recorded as being in class 1. Class 3 plants were those with firm heads and four wrapper leaves sufficiently damaged by caterpillars to be ineligible for U.S. grade No. 1.

RESULTS

Spring Treatments

Results of spring treatments are summarized in table 1. In 1963, each insecticide tested was effective against moderate infestations of the imported cabbageworm and diamondback moth /Plutella maculipennis (Curtis)/. Endrin at 0.4 pound/acre and Monsanto compounds CP-40273 and CP-40294 each at 1.0 pound/acre were superior in all respects to naled against a moderate infestation of the cabbage looper. Metacil® (Bayer 44646) at 1.0 pound/acre was superior to naled in reducing the number of class 3 plants and tended to be more effective than naled in reducing the looper population and in the production of class 1 plants. Surviving cabbage looper populations were significantly higher on plots sprayed with Bayer 41831 and Compound 4072 than on naled-treated plots. However, the plant protection provided by these compounds was equal to that provided by naled. The addition of methyl parathion to the endrin spray did not increase its effectiveness significantly. Bayer 41831 and Compound 4072 caused severe injury to the plant foliage. Monsanto CP-40273 caused slight injury to the head and surrounding leaves.

In 1964, treatments with American Cyanamid CL-47470 and Azodrin® (Shell SD-9129) resulted in the highest production of class 1 plants, each giving adequate control of the cabbage looper population, which averaged 2 loopers per plant in the untreated plots. Bayer 25141 and methyl parathion were superior to endosulfan in the production of class 1 plants and were superior to naled and parathion in protecting the plants from all degrees of injury. Niagara NIA-10242 was as effective in all respects as endosulfan and was superior to naled and parathion in preventing looper feeding. The looper control provided by Bayer 50282 and General Chemical 3707 was equal to that provided by naled and parathion. All materials tested were highly effective against very light populations of the imported cabbageworm and diamondback moth. Bayer 25141, American Cyanamid CL-47470, and methyl parathion caused severe injury to the plant foliage.

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[4] Reid, W. J., Jr. A System of Classifying Cabbage According to the Extent of Caterpillar Injury. U.S. Dept. Agr. Bur. Ent. and Plant Quar. Et-160, 7 pp. 1940.

In 1965, each material tested controlled a light infestation of the diamondback moth. All materials except American Cyanamid E.I. 47031 gave good control of the imported cabbageworm. Treatment with Azodrin resulted in the highest production of class 1 plants and gave adequate control of the cabbage looper, which averaged 1.9 larvae per untreated plant. American Cyanamid CL-47470 at 1 pound/acre was inferior to Azodrin only in the production of class 1 plants. However, this material caused severe injury to the plant foliage. Metacil at 1 pound/acre was superior to endosulfan only in reducing amounts of class 3 plants. Looper control obtained with American Cyanamid E.I. 65-1 was as good as that obtained with endosulfan. American Cyanamid E.I. 47031 and Bayer 52957 were inferior to endosulfan in reducing caterpillar injury.

Fall Treatments

Results of the fall treatments are summarized in table 2. In 1963, all of the compounds tested gave good control of a light fall armyworm infestation. Sprays of endrin at 0.4 pound/acre and Monsanto CP-40294 at 1.0 pound/acre resulted in the highest production of class 1 plants and each gave good protection against cabbage looper damage. Monsanto CP-40273 and Metacil performed equally as well as endrin but resulted in the production of fewer class 1 plants. Neither naled, Shell Development 8280, Shell Development 8803, Shell Development 8988, nor Stauffer N-2404 provided adequate control of the cabbage looper. Severe injury to the plant foliage was observed a few days after the first application of the Monsanto CP-40273 spray.

In 1964, General Chemical 9287, American Cyanamid CL-47470, and Azodrin gave good control of a relatively light population of the cabbage looper. These materials were the only ones tested that gave adequate protection to the plants. Sperlox ethyl parathion was as effective as parathion. Shell Development 9098 and Geigy GS-13005 were inferior to parathion in reducing the number of plants in class 3. The plant protection obtained with bromophos and Chemagro 4641 was inferior to that obtained with parathion. All of the compounds tested effectively controlled a light infestation of the fall armyworm. Chemagro 4641 caused severe injury to the plant foliage.

In 1965, each of the compounds tested controlled a light infestation of the fall armyworm. Against a relatively light infestation of the cabbage looper, Azodrin (at 1 pound/acre), American Cyanamid E.I. 65-1, Niagara NIA-10242, and General Chemical 6506 provided good plant protection; these materials were superior to both naled and endosulfan in the production of class 1 plants and were superior to naled in reducing the number of plants in class 3. Dursban and Metacil were superior to naled and equal to endosulfan in providing plant protection.

SUMMARY

In field tests conducted from 1963 to 1965 at Charleston, S.C., Azodrin, American Cyanamid CL-47470, Monsanto CP-40273, and Monsanto CP-40294 gave outstanding control of the cabbage looper in the spring and fall. Metacil, Niagara NIA-10242, American Cyanamid E.I. 65-1, General Chemical 6506 and 9287, and Dursban also appeared promising for looper control but were tested less extensively. The above compounds all gave adequate control of light infestations of the fall armyworm. With the exception of General Chemical 6506 and 9287 and Dursban, which were tested only against the cabbage looper and fall armyworm, all gave adequate protection against light infestations of the imported cabbageworm and the diamondback moth. Monsanto CP-40273 and American Cyanamid CL-47470 caused severe injury to the plant foliage.

CHEMICAL NAMES OF THE NEW PROPRIETARY MATERIALS TESTED

American Cyanamid CL-47470	cyclic propylene (diethoxyphosphinyl)-dithioimidocarbonate
American Cyanamid E.I. 47031	cyclic ethylene (diethoxyphosphinyl)-dithioimidocarbonate
American Cyanamid E.I. 52160[1/]	*O,O*-dimethyl phosphorothioate *O,O*-diester with 4,4'-thiodiphenol
Bayer 52957	O-5-chloro-1,2-benzisoxazol-3-yl *O,O* diethyl phosphorothioate
Metacil® (Bayer 44646)	4-(dimethylamino)-*m*-tolyl methylcarbamate
Bayer 41831	*O,O*-dimethyl *O*-4-nitro-*m*-tolyl phosphorothioate
Bayer 25141	*O,O*-diethyl *O*-[*p*-(methylsulfinyl) phenyl] phosphorothioate
Bayer 50282	4-(diallylamino)-3,5-xylyl methylcarbamate
Chemagro 4641	*S*-2,2-dichlorovinyl *O,O*-dimethyl phosphorothioate
Compound 4072	2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate
Dursban	*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate
Geigy GS-13005	*O,O*-dimethyl phosphorodithioate *S*-ester with 4-(mercaptomethyl)-2-methoxy-Δ^2-1,3,4-thiadiazolin-5-one
General Chemical 9287	1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-2-methyl-1,3,4-metheno-2*H*-cyclobuta[cd]-pentalen-2-ol

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[1/] Tested in combination with E.I. 47031 as compound 65-1.

General Chemical 6506	dimethyl *p*-(methylthio)phenyl phosphate
General Chemical 3707	dimethyl 3-hydroxyglutaconate dimethyl phosphate
Monsanto CP-40273	*O*-*p*-nitrophenyl *O*-propyl methylphosphonothioate
Monsanto CP-40294	*O*-*p*-nitrophenyl *O*-phenyl methylphosphonothioate
Niagara NIA-10242	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
Azodrin® (Shell SD-9129)	dimethyl phosphate ester with 3-hydroxyl-*N*-methyl-*cis*-crotonamide
Shell SD-9098	*O*-[2-chloro-1-(2,5-dichlorophynyl)vinyl] *O*,*O*-diethyl phosphorothioate
Shell SD-8280	2-chloro-1-(2,4-dichlorophenyl)vinyl dimethyl phosphate
Shell SD-8803	*O*-[2-chloro-1-(2,4-dichlorophenyl)vinyl] *O*,*O*-diethyl phosphorothioate
Shell SD-8988	2-bromo-1-(2,4-dichlorophenyl)vinyl dimethyl phosphate
Sperlox Ethyl Parathion	A wettable granular formulation of parathion
Stauffer N-2404	*O*-(2-chloro-4-nitrophenyl) *O*-isopropyl ethylphosphonothioate

Table 1.--Evaluation of insecticides for control of cabbage caterpillars on the spring crop, 1963-65

Insecticide and Year Tested	Pounds of active ingredient per acre per application	Number of surviving[1]			Percentage plants in-	
		Cabbage loopers[2]	Imported cabbageworms[2]	Diamondback moths[2]	Class 1[2]	Class 3[2]
1963 Tests[3]						
Monsanto CP-40294	1.0	6 ab	0 a	3 a	71.3 a	3.6 ab
	.5	14 abc	1 a	0 a	43.4 abc	15.2 a-d
Monsanto CP-40273	1.0	3 a	0 a	2 a	66.2 a	1.8 a
	.5	15 abc	1 a	1 a	33.2 abc	20.3 b-e
Endrin + methyl parathion	.4	10 ab	2 a	4 a	63.5 ab	10.6 abc
	.25	13 abc	3 a	8 a	44.2 abc	7.3 abc
Endrin	.4	9 ab	3 a	3 a	61.0 ab	3.3 ab
	.25	20 bc	8 a	5 a	21.9 bc	20.4 b-e
Metacil	1.0	12 abc	2 a	1 a	37.5 abc	10.7 abc
Naled	2.0	26 c	2 a	1 a	11.0 c	29.7 de
Compound 4072	1.0	46 d	0 a	1 a	5.4 c	23.3 cde
Bayer 41831	1.0	48 d	1 a	0 a	3.6 c	32.9 e
Untreated	---	108 e	150 b	49 b	0 c	95.9 f
1964 Tests[3]						
American Cyanamid CL-47470	1.0	2 a	0	0	99 a	0 a
Azodrin	1.0	4 a	0	0	95 a	0 a
Methyl parathion	1.5	7 a	0	0	66 b	2 a
Bayer 25141	1.0	20 ab	0	0	56 bc	6 a
Niagara NIA-10242	1.0	45 abc	0	0	43 cd	3 a
Endosulfan	1.0	46 abc	0	0	34 de	10 ab
Parathion	.5	63 bcd	0	0	13 f	30 e
Naled	2.0	47 abc	0	0	11 f	28 de
General Chemical 3707	1.0	80 cd	0	0	10 f	27 cde
Bayer 50282[4]	1.0	106 d	0	0	3 f	20 b-e
Untreated	---	201 e	10	6	0 f	78 g

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[1] Average number larvae and pupae of the cabbage looper, imported cabbageworm, and diamondback moth per 100 plants.

[2] Values within columns not followed by any letters in common are significantly different as determined by Duncan's multiple range test at the 5 percent level.

[3] Five applications of each insecticide from early May to early June.

[4] Wettable powder.

Table 1.--Continued

Insecticide and Year Tested	Pounds of active ingredient per acre per application	Number of surviving[1]			Percentage plants in-	
		Cabbage loopers[2]	Imported cabbageworms[2]	Diamondback moths[2]	Class 1[2]	Class 3[2]
1965 Tests[3]						
Azodrin	1.0	12 a	1 a	0	82.5 a	0 a
	.5	44 bc	0 a	.4	40.2 c	10.6 a
American Cyanamid CL-47470	1.0	11 a	1 a	0	59.7 b	2.7 a
	.5	53 bcd	2 a	0	5.9 de	49.7 cd
Metacil[4]	1.0	54 bcd	.4 a	1	17.0 d	28.5 b
	.5	105 e	4 a	0	1.2 e	67.8 e
American Cyanamid 65-1[5]	.5	37 ab	5 a	0	16.7 d	39.3 bc
Endosulfan	1.0	52 bcd	5 a	0	9.2 de	50.6 cd
Bayer 52957	1.0	80 d	3 a	.8	.7 e	75.7 e
American Cyanamid E.I. 47031	.25	43 bc	33 b	1	.3 e	72.1 e
Untreated	---	186 d	94 c	20	0 e	94.8 f

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[5] Formulated by manufacturer to contain equal parts by weight of E.I. 47031 and E.I. 52160.

Table 2.--Evaluation of insecticides for control of cabbage caterpillars on the fall crop, 1963-65

Insecticide and Year Tested	Pounds of active ingredient per acre per application	Number of surviving[1]		Percentage plants in-	
		Cabbage loopers[2]	Fall armyworms[2]	Class 1[2]	Class 3[2]
1963 Tests[3]					
Endrin	0.4	24 a	3 ab	88 a	1 a
Monsanto CP-40294	1.0	17 a	3 ab	87 a	0 a
	.5	45 a	2 ab	63 c	4 a
Monsanto CP-40273	1.0	12 a	1 ab	77 b	4 a
	.5	21 a	1 ab	59 d	6 a
Metacil	1.0	25 a	0 a	59 d	4 a
Naled	2.0	44 a	1 ab	23 e	15 b
Shell SD-8803	1.0	148 c	5 b	20 f	18 bc
Stauffer N-2404	1.0	94 b	2 ab	15 g	25 cd
Shell SD-8280[4]	1.0	79 b	1 ab	14 g	25 bcd
Shell SD-8988	1.0	96 b	0 a	13 g	29 d
Untreated	---	216 d	11 c	4 h	51 e

Table 2.--Continued

Insecticide and Year Tested	Pounds of active ingredient per acre per application	Number of surviving[1]		Percentage plants in-	
		Cabbage loopers[2]	Fall armyworms[2]	Class 1[2]	Class 3[2]
1964 Tests[5]					
General Chemical 9287[4]	1.0	9 a	0	93.0 a	1.8 a
Azodrin	.5	8 a	2	87.6 a	2.6 a
American Cyanamid CL-47470	.5	11 ab	0	83.7 a	4.7 a
Parathion	.5	16 ab	0	54.1 bc	21.7 c
Geigy GS-13005	1.0	19 ab	2	53.5 bc	26.7 d
Sperlox Ethyl Parathion[6]	.5	21 b	3	48.7 cd	18.2 c
Shell SD-9098	1.0	25 b	0	43.5 cd	27.6 d
Bromophos	1.0	26 b	2	36.5 d	38.8 e
Chemagro 4641	1.0	42 c	6	22.5 e	48.4 f
Untreated	---	80 d	76	11.4 e	67.0 g
1965 Tests[3]					
American Cyanamid 65-1[7]	2.0	1 a	.3 a	98.5 a	.1 a
Azodrin	1.0	4 abc	0 a	97.7 a	.8 a
	.5	18 c-f	.7 a	90.1 ab	.9 a
General Chemical 6506	1.0	5 abc	.3 a	96.3 a	0 a
	.5	18 c-f	2.7 a	89.0 ab	1.1 a
Dursban	1.0	6 a-d	2.0 a	92.1 ab	1.5 a
	.5	20 ef	.3 a	57.9 de	3.4 ab
Niagara NIA 10242[4]	2.0	4 abc	.7 a	90.8 ab	1.1 a
Metacil[4]	1.0	10 a-e	2.0 a	83.3 ab	1.8 a
Endosulfan	1.0	11 a-e	4.7 a	75.6 bc	4.0 ab
Naled	2.0	14 a-e	2.3 a	63.4 cd	6.9 bc
Untreated	---	61 g	21.0 b	5.7 g	52.3 e

1/ Average number larvae and pupae of the cabbage looper and larvae of the fall armyworm per 100 plants.

2/ Values within columns not followed by any letters in common are significantly different as determined by Duncan's multiple range test at the 5 percent level.

3/ Five applications of each insecticide from mid-September to mid-October.

4/ Wettable powder.

5/ Seven applications of each insecticide from mid-September to mid-November.

6/ Wettable granules.

7/ Formulated by manufacturer to contain equal parts by weight of E.I. 47031 and E.I. 52160.